INL/MIS-19-53041-Revision-0

PRISM Presentation

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PRISM

A Volume Visualization Tool

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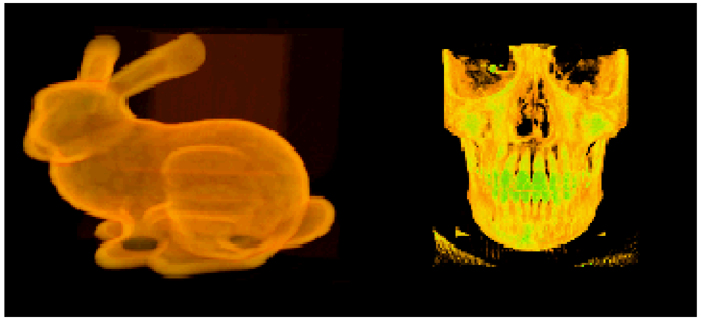

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PRISM: Progressive Resolution for Imaging and Storage Management

- PRISM is a framework for rendering high scale volumetric data.
- This tool was developed by the following people, under the support of Idaho National Laboratory:
  - James Money
  - Marko Sterbentz
  - Nathan Morrical
  - Landon Woolley
  - Thomas Szewczyk
  - Randall Reese
- Current point of contact is Thomas Szewczyk (thomas.szewczyk@inl.gov)

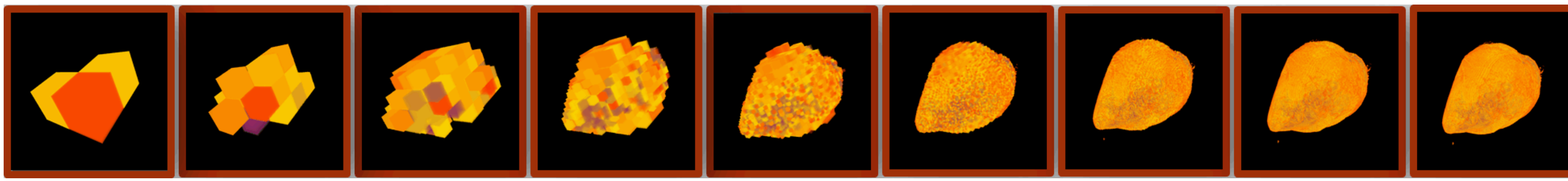
Use of Unity 3D game engine

- PRISM is based in the Unity 3D game engine.
- By using a commodity game engine, one can utilize PRISM on a large variety of platforms:
  - Desktop computers
  - Virtual reality headsets
  - Smart phones
  - Cave Automatic Virtual Environment (CAVE)

Hierarchical Z-Ordering

- Volumes are taken as a collection of voxels.
- Given a volume to be rendered, we divide each volume into a collection of cubes (“bricks”).
- Each brick has edge length a power of 2.
  - E.g. 256 x 256 x 256 voxels.
- Different bricks can have different edge lengths.
- By ordering the voxels of each brick in a hierarchical Z-order Morton curve (a type of space filling curve), we can control the rendered level of detail for each brick. (See next slide)

Increasing Z-Level: Sheep Heart.



Z = 0 Z = 1 Z = 2 Z = 3 Z = 4 Z = 5 Z = 6 Z = 7 Z = 8

- As Z-level increases, the level of detail also increases.
- This allows the user to cull the level of detail as desired.
- Sometimes less than “full” level of detail is sufficient.
- This decreases the amount of necessary data and render time.

PRISM Controls

Controls the maximum number of steps that each ray will make.

Controls the intensity scaling of the RGBa values for with each ray.

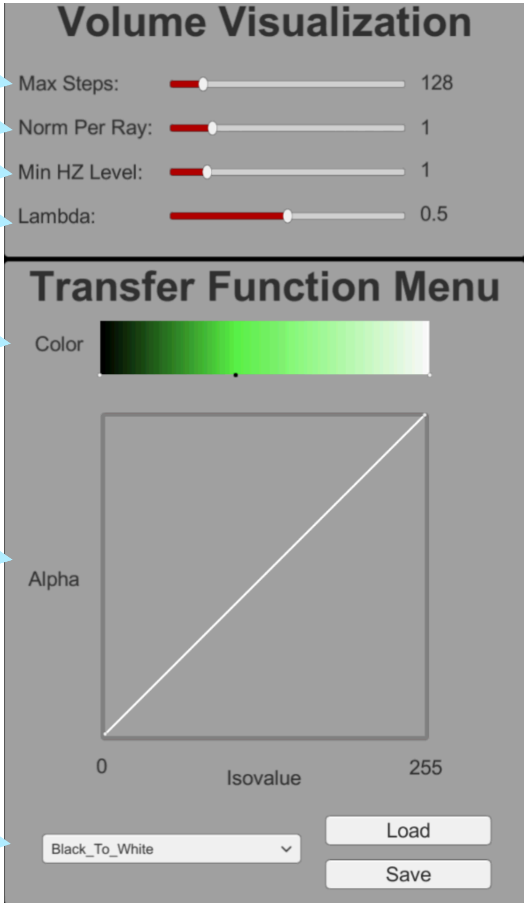
Controls the minimum Z-level that a voxel may be rendered at.

Controls the dampening of the LOD culling function.

Color panel for transfer function. Determines color value for each isovalue.

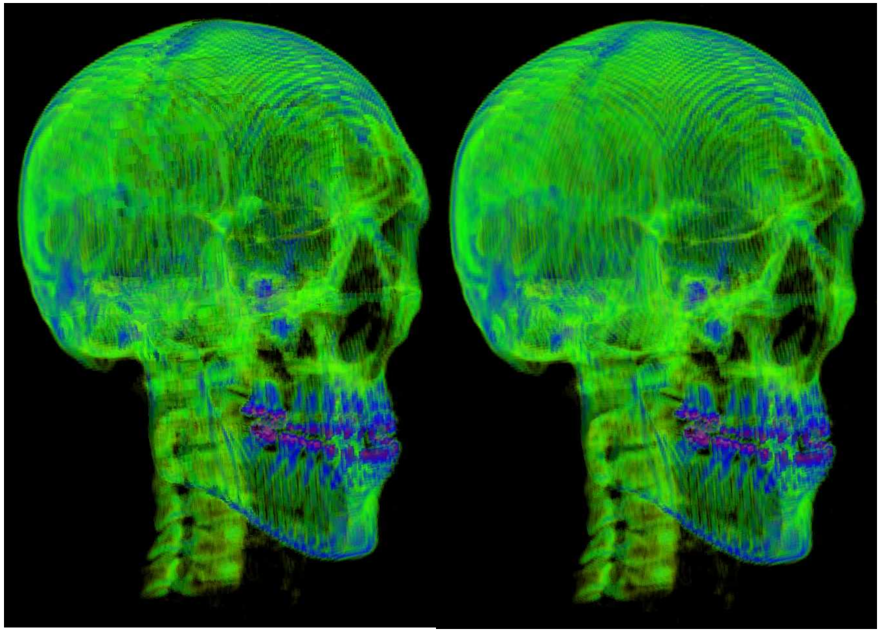
Transfer function curve. Controls transparency of each isovalue.

Transfer function selection. User selects which transfer function to use.

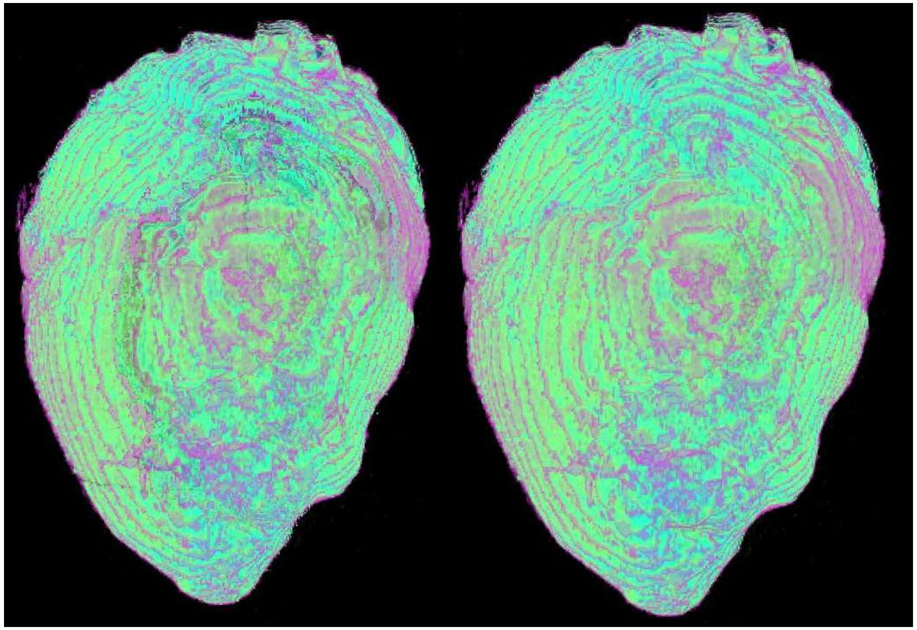


Visibility-based Level of Detail Culling

- We can cull the level of detail of individual bricks or voxels based on their visibility relative to the camera by reducing the Z-level of occluded bricks.
- This can exponentially reduce the amount of data that must be displayed without noticeably reducing the image quality.



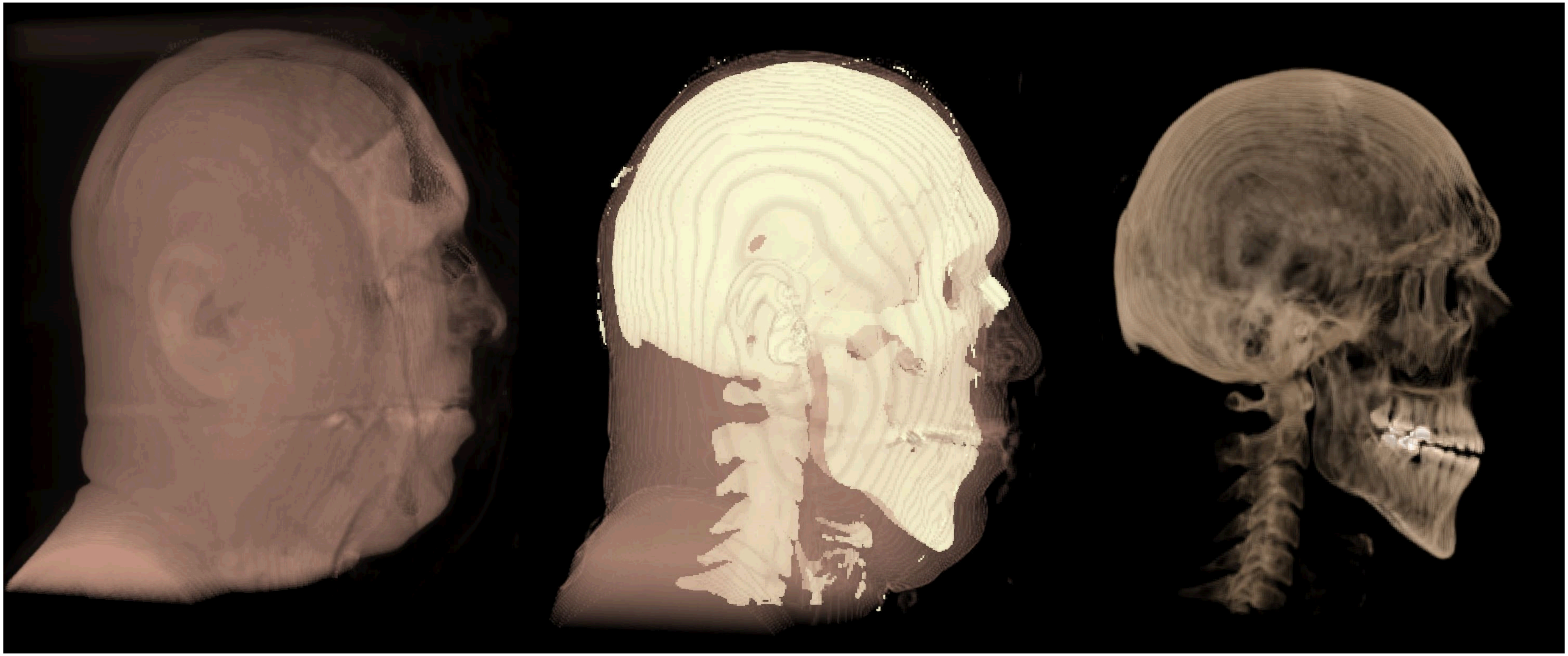
Culled (left) and non-culled (right) skull volume.



Culled (left) and non-culled (right) sheep heart volume.

Revealing Isolayers

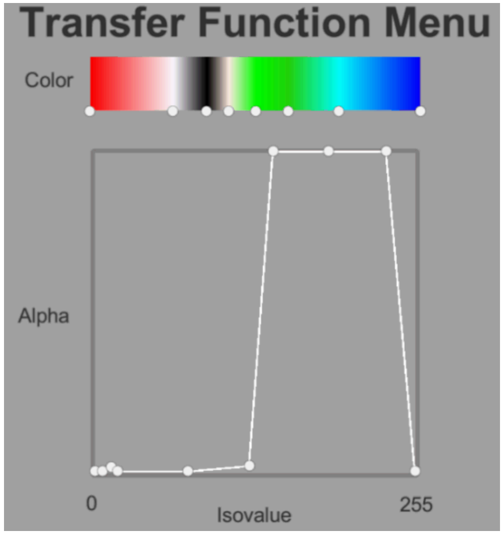
- Using the transfer function manipulation capabilities of PRISM, we can reveal different isolayers of the volume in question:



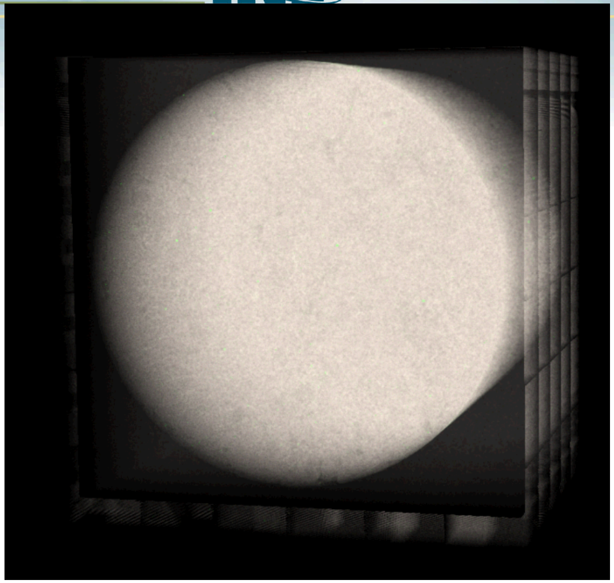
Three isolayers of the Visible Male (left to right): [1] Skin [2] Skull in skin [3] Skull

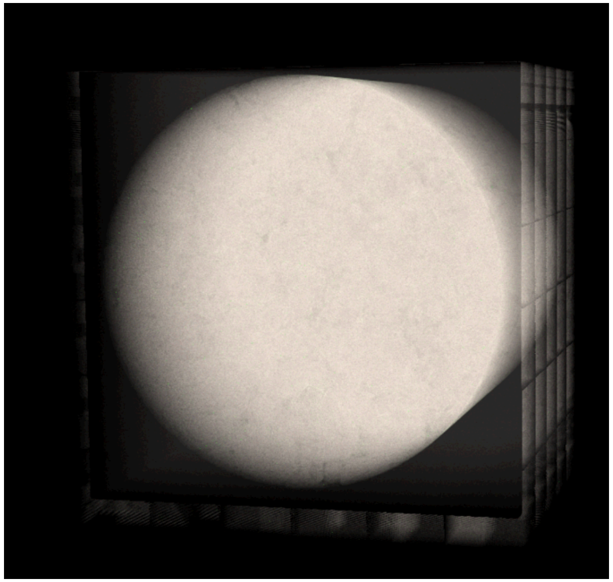
Rendering a 25 GB Volume

- We used PRISM to render a cylinder of carbon material.
- In its raw data form, this data set is nearly 25 GB large.
- By selectively culling the Z-level of each brick in the volume, we can render the carbon cylinder without overloading machine resources.
- Shown here are two images of the volume, one with a minimum Z-level of 5 and one with a minimum Z-level of 8.



Transfer function used for both renderings.


Cylinder at min Z-Level 5


Cylinder at min Z-Level 8